JP2001-166272_E

[Title of the Invention] PANEL ASSEMBLING METHOD AND APPARATUS

[Abstract]

[Object] To provide a panel assembling method and a panel assembling apparatus in which an upper panel and a lower panel having the same shape can be bonded to each other in vacuum.

[Solving Means] Two sheets of panels are disposed to oppose each other and then are bonded to each other with an adhesive provided on one panel. By holding the two sheets of panels in vacuum to oppose each other and then releasing the holding of the upper panel to drop the upper panel, the two sheets of panels are bonded to each other.

[Claims]

[Claim 1] A panel assembling method in which two sheets of panels are disposed to oppose each other and then are bonded to each other with an adhesive provided on one panel, wherein the two sheets of panels are bonded to each other by vertically holding the two sheets of panels in vacuum to oppose each other and then releasing the holding of the upper panel to drop the upper panel.

[Claim 2] The panel assembling method according to Claim 1,

wherein the upper panel is guided and dropped onto the lower panel.

[Claim 3] The panel assembling method according to Claim 1, wherein the upper panel is dropped onto the lower panel in a state where a warped portion of the upper panel comes in contact with the lower panel which is held horizontal.

[Claim 4] The panel assembling method according to Claim 1, wherein the two sheets of panels are positioned with respect to each other before or after the upper panel is dropped onto the lower panel.

[Claim 5] A panel assembling apparatus for disposing two sheets of panels to oppose each other and then bonding the two sheets of panels to each other with an adhesive provided on one panel, the apparatus comprising a holding release means for holding the two sheets of panels in vacuum to oppose an upper panel to a lower panel and then releasing the holding of the upper panel to drop the upper panel onto the lower panel.

[Claim 6] The panel assembling apparatus according to Claim 5, further comprising a table for holding the lower panel horizontal.

[Claim 7] The panel assembling apparatus according to Claim 5, wherein the holding release means holds opposite sides or opposite corner portions of the upper panel and has means for bringing a warped portion of the upper panel into

contact with the lower panel which is held horizontal.

[Detailed Description of the Invention]

[0001]

[Industrial Applicability]

The present invention relates to a panel assembling method and a panel assembling apparatus for assembling a panel by opposing two sheets of panels to each other and narrowing a gap between two panels in vacuum.

[0002]

[Description of the Related Art]

In manufacturing liquid crystal display panels, there is a process in which two sheets of glass panels on which transparent electrodes or a thin film transistor array are formed are bonded to each other with an adhesive (hereinafter, also referred to as "sealing material") with a very small gap of several microns therebetween (hereinafter, the bonded panel is referred to as a "cell") and liquid crystal is enclosed in the gap therebetween.

[0003]

As a technique for enclosing the liquid crystal, there is known a method disclosed in Japanese Unexamined Patent Application Publication No. S62-165622 in which the liquid crystal is dropped on one panel on which the sealing material is drawn in a closed pattern without an injection

port, the other panel is disposed above the panel, and then the panels are bonded to each other by allowing the panels to approach each other in vacuum or a method disclosed in Japanese Unexamined Patent Application Publication No. H10-26763 in which the sealing material is drawn in a pattern with an injection port on one panel, the panels are bonded to each other in vacuum, and then the liquid crystal is injected through the injection port of the sealing material.

[0004]

[Problems to be Solved by the Invention]

In the above-mentioned techniques, two panels are bonded to each other in vacuum. However, since the panels cannot be adsorbed in vacuum using the pressure difference from the atmosphere, edges of an upper panel are mechanically held. As a result, in order to drop the upper panel while positioning the upper panel with respect to a panel on a table (hereinafter, referred to as "lower panel"), it is necessary to enlarge the upper panel because holding tolerance should be provided to the upper panel such that the held portion does not interfere with the lower panel. Therefore, the upper panel and the lower panel could not have the same shape.

[0005]

In addition, since positioning marks on the upper and lower panels are detected and the upper panel is dropped

while positioning the panels, it takes time to bond the panels, thereby reducing productivity.

[0006]

Therefore, it is an object of the present invention to provide a panel assembling method and a panel assembling apparatus which the upper and lower panels having the same shape can be bonded to each other in vacuum.

[0007]

It is another object to provide a panel assembling method and a panel assembling apparatus which can enhance the productivity by bonding the panels in vacuum for a short time.

[0008]

[Means for Solving the Problems]

In order to accomplish the above-mentioned objects, the present invention is characterized by disposing two sheets of panels to oppose each other and then bonding the two sheets of panels to each other with an adhesive provided on one panel, wherein the two sheets of panels are bonded to each other by vertically holding the two sheets of panels in vacuum to oppose each other and then releasing the holding of the upper panel to drop the upper panel.

[0009]

When the upper panel is dropped in the atmosphere, the air existing between the two panels hinders the dropping of

the upper panel and thus the upper panel is not dropped onto the lower panel with the position at the time of releasing the holding of the upper panel. This is the same reason that leaves or papers are dropped with fluttering. A thin body with great weight is not dropped surely vertically because of viscous resistance against the air, thereby causing deviation in position.

[0010]

According to the present invention, since no gas exists between two panels, it is possible to bond two panels to each other by using the fact that the upper panel is surely vertically dropped onto the lower panel only by releasing the upper panel.

[0011]

[Embodiments]

Now, an embodiment of the present invention will be described with reference the attached drawings.

[0012]

In Figs. 1 to 3, a panel assembling apparatus according to the present invention comprises a liquid crystal dropping unit S1 and a panel bonding unit S2. The units are disposed adjacent to each other on a stand 2. A frame 3 for supporting the panel bonding unit S2 is disposed above the stand 2. The surface of the stand 2 is provided with an XYθ stage T1. An X stage 4a is movable with a driving motor 5

in the X axis direction, that is, between the liquid crystal dropping unit S1 and the panel bonding unit S2. An Y stage 4b is disposed on the X stage 4a and is movable with a driving motor 6 in the Y axis direction perpendicular to the X axis direction in which the X stage 4a is moved.

[0013]

A θ stage 4c is disposed on the Y stage 4b and is rotatable horizontally about the Y stage 4b with a driving motor 8 through a rotation bearing 7. A table 9 for mounting a lower panel 1a is fixed onto the θ stage 4c. The table 9 has means for holding the lower panel 1a using vacuum adsorption (suctorial adsorption). A lower chamber unit 10 is fixed to the Y stage 4b with a plate 13. The θ stage 4c is rotatably provided to the lower chamber unit 10 through the rotation bearing 11 and a vacuum seal 12. When the θ stage 4c rotates, the lower chamber unit 10 does not rotate together.

[0014]

The liquid crystal dropping unit S1 comprises a dispenser 17 supported by a bracket 14 protruded from the frame 3 so as to drop a desired amount of liquid crystal onto the lower panel 1a held on the table 9, a Z stage 15 for vertically moving the dispenser 17, and a motor 16 for driving the Z stage 15. The XYθ stage T1 in which the lower panel 1a is mounted on the table 9 is moved in the X and Y

directions with respect to a nozzle 18 of the dispenser 17 for dropping the liquid crystal. As a result, the desired amount of liquid crystal can be dropped at any position on the lower panel 1a. The XYθ stage T1 in which the liquid crystal has been dropped onto the lower panel 1a is moved below the panel bonding unit S2 by the driving motor 5.

[0015]

In the panel bonding unit S2, the upper chamber unit 21 and the pressing plate 27 having a vacuum adsorption function are vertically movable independent of each other. That is, the upper chamber unit 21 has a housing 30 with a linear bush and a vacuum seal built in and is moved in the Z axis direction by the cylinder 22 fixed to the frame 3.

[0016]

When the XYθ stage T1 is moved to the panel bonding unit S2 and the upper chamber unit 21 goes down, a flange 21a of the upper chamber unit 21 comes in contact with an O ring 44 disposed around the lower chamber unit 10 to form a body, which serves as a vacuum chamber.

[0017]

Reference numeral 23 denotes a vacuum valve and reference numeral 24 denotes a piping hose connected to a vacuum source not shown, which are used for decompressing the vacuum chamber into vacuum. Reference numeral 25 denotes a gas purge valve and reference numeral 26 denotes a

gas tube connected to a pressure source for nitrogen gas, clean dry air, or the like, which are used for restoring the pressure of the vacuum chamber to the atmospheric pressure.

[0018]

The housing 30 has a vacuum seal which is vertically movable with respect to the shaft 29 without vacuum leakage even when the upper chamber unit 21 and the lower chamber unit 10 are deformed to form the vacuum chamber. As a result, the housing can absorb a force given to the shaft 29 due to the deformation of the vacuum chamber, most deformation of the pressing plate 27 fixed to the shaft 29 can be prevented, and the pressing plate 27 can be lowered while maintaining parallel to the table 9.

[0019]

The upper panel 1b is held on the lower surface of the pressing plate 27 by means of vacuum adsorption (suctorial adsorption) in the atmosphere. That is, reference numeral 41 denotes a suctorial adsorption joint and reference numeral 42 denotes a suction tube connected to a vacuum source not shown. A plurality of suction holes connected to the suction tube is provided in the lower surface of the pressing plate 27.

[0020]

The pressing plate 27 is attached to the shaft 29 and the shaft 29 is fixed to the housings 31 and 32. The

housing 31 is attached to a frame 2 through a linear guide 34 and the pressing plate 27 is vertically movable. The vertical movement is performed by a motor 40 fixed to a bracket 38 on a frame 35 connected to the frame 3. The delivery of driving power is performed by a ball screw 36 and a nut housing 37. The nut housing 37 is connected to the housing 32 through a load meter 33 and works as one body along with the pressing plate 27. Therefore, the pressing plate 27 goes down with the descent of the shaft 29 by the motor 40, thereby giving a pressing force to the upper panel 1b and the lower panel 1a bonded to each other.

[0021]

In this case, the load meter 33 serves as a pressing force sensor and can give the desired pressing force to the upper and lower panels 1a and 1b by controlling the motor 40 on the basis of signals sequentially fed back.

[0022]

In the course of decompressing the vacuum chamber into vacuum after the lower panel 1a is adsorbed and held by the table 9 with the vacuum adsorption and the upper panel 1b is adsorbed and held by the pressing plate 27 with the vacuum adsorption, the adsorptive force applied to the upper and lower panels 1a and 1b is cancelled. Accordingly, the air between the lower panel 1a and the table 9 or between the upper panel 1b and the pressing plate 27 gets out so that

the lower panel 1a may be deviated in position or the upper panel 1b may be dropped with its own weight. As a result, the lower chamber unit 10 is provided with a mechanism for preventing the movement of the lower panel 1a and holding the upper panel 1b and a mechanism (shown in Figs. 2 and 3) for dropping the upper panel 1b at a predetermined position. That is, in the mechanisms for preventing the movement and holding the panel or dropping the panel at the predetermined position, as shown in Figs. 2 and 3, position holding pieces 51 for positioning the lower panel 1a by pressing four corners of the lower panel 1a placed on the table 9 in the X and Y directions or holding the upper panel 1b a guide mechanism 56 for positioning the lower panel 1a by pressing the four corners of the lower panel 1a placed on the table 9 in the X and Y directions or dropping the upper panel 1b at the predetermined position are guided with the linear guide 52 of the θ stage 4c. In addition, the position holding pieces 51 and the guide mechanism 56 are pulled toward the inner wall of the lower chamber unit 10 by a spring 53. The outer circumference of a flange portion 10a of the lower chamber unit 10 is provided through a bracket 55 with a cylinder 54 extending from a plunger 54a toward the position holding pieces 51 or the guide mechanism 56 in the lower chamber unit 10. In the cylinder 54, the plunger 54a presses the side surfaces of the lower panel 1a with the

position holding pieces 51 against the biasing force of the spring 53 and the guide mechanism 56 presses the side surfaces of the upper and lower panels 1a and 1b.

[0023]

Each position holding piece 51 has a vertical portion 51a and a horizontal portion 51b extending from the vertical portion 51a in parallel to the panels. As shown in Fig. 2, the horizontal portion 51b is spaced from the upper surface of the lower panel 1a at the lower side and comes in contact with the lower surface of the upper panel 1b at the upper side. In addition, the vertical portion 51a comes in contact with the side surfaces of the lower panel 1a, as shown in Fig. 2.

[0024]

The guide mechanism 56 comes in contact with the side surfaces of the upper and lower panels 1a and 1b, as shown in Fig. 2. The pressing plate 27 is provided with a concave portion 27a extending in the Z axis direction for fitting the guide mechanism 56, thereby making smooth the movement of the pressing plate 27 even when the guide mechanism 56.

[0025]

Next, a process of bonding panels by using the panel assembling apparatus according to the present invention will be described.

[0026]

First, as shown in Fig. 1, the lower panel 1a on which a sealing material is drawn in a closed pattern without an injection port is mounted on the table 9, the lower panel 1a is positioned by driving the position holding pieces 51 at four corners with the cylinder 54, the lower panel is held by the table 9 with the vacuum adsorption, the plungers 54a are withdrawn, and the position holding pieces 51 are withdrawn. Thereafter, the upper panel 1b is adsorbed (by means of vacuum) and held by the pressing plate 27 by using a robot hand not shown. The XYθ stage T1 is moved to the panel bonding unit S2 by the driving motor 5. The positioning marks of the respective panels 1a and 1b are read out with an image processing camera not shown and provided in the upper chamber unit 21, and the XYθ stage T1 is minutely moved to position the panels 1a and 1b. In positioning the panels, the ball screw 36 is rotated with the motor 40, thereby slightly lowering the pressing plate 27 so as to make it easy to read out the positioning marks of the respective panels 1a and 1b with the camera. Thereafter, the lower panel 1a is returned to the liquid crystal dropping unit S1 with the XYθ stage T1 and a desired amount of liquid crystal is supplied inside the sealing material having a closed pattern on the lower panel 1a from the dispenser 17. Then, the lower panel 1a is moved again to the panel bonding unit S2 with the XYθ stage T1. At this

time, since the amount of movement can be checked on the basis of the amount of rotation of the driving motor 5, the deviation in position between the two panels 1a and 1b is not caused.

[0027]

Next, by moving the position holding pieces 51 with the plungers 54a of the cylinders 54, the side surface and the four corners of the upper surfaces of the lower panel 1a are pressed with the vertical portions 51a and the horizontal portions 51b of the position holding pieces 51. Next, the lower surface of the upper panel 1b comes close to the upper surface of the horizontal pieces 51b of the position holding pieces 51 by lowering the pressing plate 27, and then the four corners of the side surfaces of the upper and lower panels 1a and 1b are pressed loose by moving the guide mechanism 56 with the plungers 54a of the cylinders 54.

[0028]

Thereafter, the upper chamber unit 21 is lowered with the cylinder 22 to form the vacuum chamber and then the decompression of the vacuum chamber is started. In the course of decompressing the vacuum chamber, the air existing between the respective panels 1a and 1b and the table 9 or the pressing plate 27 is taken out. However, since the movement of the respective panels 1a and 1b are regulated by the position holding pieces 51 and the guide mechanisms 56,

the panels are not moved due to the flow of air. That is, even when the lower panel 1a is floated, the lower surfaces of the horizontal portions 51b press the lower panel 1a and the vertical portions 51a and the guide mechanisms 56 regulate the movement in the X and Y directions.

[0029]

Since the adsorptive force by the pressing plate 27 disappears, the upper panel 1b is dropped onto and held by the upper surfaces of the horizontal portions 51b of the position holding pieces 51 with its own weight. The guide mechanisms 56 regulate the movement of the upper panel in the X and Y directions at the time of dropping the upper panel.

[0030]

When the vacuum chamber has the desired degree of vacuum, the position holding pieces 51 are withdrawn and thus the upper panel 1b is dropped onto the lower panel 1a, thereby bonding the upper and lower panels 1a and 1b.

[0031]

Since the upper panel 1b is dropped onto the lower panel 1a only by withdrawing the position holding pieces 51, the bonding of the upper and lower panels 1a and 1b are completed for a short time and the two panels 1a and 1b can have the same size. Panels having different sizes may be used as needed.

[0032]

The upper panel 1b is vertically dropped onto the lower panel 1a. However, even when reasons for causing the deviation in position occur unexpectedly, the upper panel 1b is dropped to the determined position on the lower panel 1a since the guide mechanisms 56 regulate the movement of the upper panel in the X and Y directions.

[0033]

By lowering the pressing plate 27, the upper and lower panels 1a and 1b are pressed and bonded to each other with a desired gap therebetween. In the course of bonding and pressing the panels, since the movement of the two panels 1a and 1b in the X and Y directions is regulated by the guide mechanisms 56, the deviation in position does not occur.

[0034]

In the above-mentioned embodiment, the movement at the time of dropping the upper panel 1b is regulated by the guide mechanisms 56. However, by rapidly withdrawing the position holding pieces 51 in synchronization with each other without using the guide mechanisms 56, the upper panel 1b can be vertically dropped with inertia due to no air in vacuum. Accordingly, at the time of dropping the upper panel 1b, the guide mechanisms 56 may be withdrawn, the upper panel 1b may be dropped, and the upper panel may be then pressed and bonded to the lower panel. As a result,

the guide mechanisms 56 may be omitted.

[0035]

After dropping the upper panel 1b, the guide mechanisms 56 may be moved with the plungers 54a of the cylinders 54 and four corners of the side surfaces of the upper and lower panels 1a and 1b may be pressed, thereby positioning and bonding the panels.

[0036]

The guide mechanism 56 is movable but the bonding can be performed without moving the guide mechanism. As a result, the guide mechanism may be fixed to the stage 4c or the table 9.

[0037]

After bonding the panels, the vacuum chamber is restored to the atmospheric pressure and the upper chamber unit 21 is lifted with the cylinder 22 to return the XYθ stage T1 to the liquid crystal dropping unit S1. Then, the bonded panels 1a and 1b (cell) are separated from the table 9.

[0038]

Fig. 4 is a diagram illustrating a second embodiment of the present invention. The same elements as shown in Fig. 2 are denoted by the same reference numerals and descriptions thereof will be omitted.

[0039]

In the present embodiment, the pressing plate 27 is lowered to bring the lower surface of the upper panel 1b into contact with the horizontal portions 51b of the position holding pieces 51 and then the vacuum chamber is decompressed.

[0040]

Then, the adsorptive force for holding the upper panel 1b disappears and the upper panel 1b is held on the position holding pieces 51 with its own weight. At this time, since the upper panel 1b comes in contact with the surfaces of the horizontal portions 51b of the position holding pieces 51 and thus its movement is regulated, the upper panel is not moved due to the flow of air generated at the time of decompression.

[0041]

Since the upper panel 1b held on the position holding pieces 51 is warped with its own weight, the height of the horizontal portions 51b of the position holding pieces 51 is set to the height at which the upper panel 1b is warped to contact with the lower panel 1a.

[0042]

When the desired degree of vacuum is reached, the position holding pieces 51 are withdrawn to drop the upper panel 1b onto the lower panel 1a and the upper and lower panels 1a and 1b are bonded to each other.

[0043]

Since the upper and lower panels 1a and 1b are in contact with each other at the warped portion of the upper panel, a frictional resistance is generated between both panels 1a and 1b at the time of dropping the upper panel. Since the movement of the upper panel 1b is regulated by the frictional resistance, the upper panel 1b is dropped to the predetermined position on the lower panel 1a without the guide mechanisms 56 shown in Fig. 2 and used in the first embodiment. The upper and lower panels 1a and 1b are pressed by lowering the pressing plate 27, thereby bonding the two panels 1a and 1b with a desired gap therebetween. Specifically, by holding two opposite sides or two opposite corners of the upper panel 1b using the position holding pieces 51, two opposite sides or corners of the upper panel 1b come in contact with the lower panel 1a in a band shape. Accordingly, by providing the positioning marks of the two panels 1a and 1b at the positions, the positioning accuracy with the image recognizing camera is improved.

[0044]

In addition, by providing pillar-shaped spacers or bonding beads on the lower panel 1a, the gap between the upper and lower panels 1a and 1b after the bonding can be kept constant even when the warped upper panel 1b is in contact with the lower panel 1a. As shown in Fig. 2, the

guide mechanisms 56 may be combined.

[0045]

Fig. 5 is a diagram illustrating a third embodiment of the present invention. Similar to Fig. 4, the same elements as shown in Fig. 2 are denoted by the same reference numerals and descriptions thereof will be omitted.

[0046]

In Fig. 5, reference numeral 57 denotes a positioning piece, reference numeral 58 denotes a panel holding guide, and reference numeral 59 denotes a shaft. The panel holding guide 58 which is rotated about the shaft 59 is provided in the vicinity of four corners of the upper panel 1b and the panel holding guide 58 has a flat portion 58a. In place of the position holding piece 51 shown in Fig. 2, the positioning piece 57 is provided in the vicinity of four corners of the lower panel 1a, respectively.

[0047]

As shown in Fig. 5(a), the pressing plate 27 adsorbing the upper panel 1b with the vacuum adsorption is lowered, the lower surface of the upper panel 1b is brought into contact with the upper surface of the flat portion 58a of the panel holding guide 58, and then the vacuum chamber is decompressed. Then, the adsorptive force holding the upper panel 1b disappears and the upper panel 1b is held on the panel holding guides 58 with its own weight. At this time,

since the four corners of the upper panel 1b are interposed between the upper surfaces of the flat portions 58a of the panel holding guides 58 and the pressing plate 27 to regulate its movement, the upper panel is not moved due to the flow of air generated at the time of decompression.

[0048]

When the vacuum chamber reaches the desired degree of vacuum, as shown in Fig. 5(b), all the panel holding guides 58 are simultaneously rotated by 90 degrees in the arrow direction such that the flat portions 58a are vertical. Then, the upper panel 1b is dropped onto the lower panel 1a.

[0049]

Since the flat portions 58a of the panel holding guides 58 serve as a guide for the upper panel 1b to regulate the movement of the upper panel 1b in the X and Y directions, the upper panel is dropped to the determined position. Then, the pressing plate 27 is further lowered so as to press the upper and lower panels 1a and 1b, thereby bonding the two panels 1a and 1b with a desired gap therebetween.

[0050]

The panel holding guides 58 may have any shape only if they have the flat portions 58a.

[0051]

Fig. 6 is a diagram illustrating a fourth embodiment of the present invention. Similar to Fig. 5, the same elements

as shown in Fig. 2 are denoted by the same reference numerals and descriptions thereof will be omitted.

[0052]

In Fig. 6, reference numeral 57 denotes the same positioning pieces as shown in Fig. 5, reference numeral 60 denotes a panel holding piece, and reference numeral 59 denotes a shaft. The panel holding piece 60 rotating about the shaft 59 is similar to the panel holding guide 58 shown in Fig. 5, except that the horizontal cross-section has a cross shape.

[0053]

As shown in Fig. 6(a), similar to the embodiment illustrated in Fig. 5, the pressing plate 27 is lowered, the lower surface of the upper panel 1b is brought into contact with the horizontal portions of the panel holding pieces 60, and then the vacuum chamber is decompressed. Then, the adsorptive force holding the upper panel 1b disappears and the upper panel 1b is held on the panel holding pieces 60 with its own weight. At this time, since the movement of the upper panel 1b is regulated with the vertical portions of the panel holding pieces 60, the upper panel is not moved due to the flow of air generated at the time of decompression.

[0054]

When the vacuum chamber reaches the desired degree of

vacuum, as shown in Fig. 6(b), all the panel holding pieces 60 are simultaneously rotated by 90 degrees in the arrow direction and the upper panel is dropped onto the lower panel 1a, thereby bonding the upper and lower panels 1a and 1b. Since the air resistance does not exist in vacuum and thus the upper panel 1b is vertically dropped with the gravitational force, the upper panel 1b is dropped to the determined position. Thereafter, the pressing plate 27 is further lowered so as to press the upper and lower panels 1a and 1b, thereby bonding the panels 1a and 1b with a desired gap therebetween.

[0055]

In the present embodiment, since the panel holding pieces 60 release the holding of the upper panel 1b so as to drop the upper panel 1b, the upper panel 1b is apt to be vertically dropped. Although not shown in the figure, the guide mechanisms 56 may be combined as shown in Fig. 2.

[0056]

Fig. 7 is a diagram illustrating a fifth embodiment of the present invention. Similar to Fig. 5, the same elements as shown in Fig. 2 are denoted by the same reference numerals and descriptions thereof will be omitted.

[0057]

In Fig. 7, reference numeral 61 denotes a position holding guide. In the present embodiment, the position

holding guides 61 in which a vertical portion is provided on the upper surface of the position holding piece 51 shown in Fig. 2 are provided at the four corners of the panel.

[0058]

As shown in Fig. 7(a), the pressing plate 27 holding the upper panel 1b is lowered, the lower surface of the upper panel 1b is brought into contact with the position holding guides 61, and then the vacuum chamber is decompressed. Then, the adsorptive force holding the upper panel 1b disappears and the upper panel 1b is dropped and held on the position holding guides 61 with its own weight as shown in the figure. At this time, since the movement of the upper panel 1b in the X and Y directions is regulated with the position holding guides 61, the upper panel is not moved in the X and Y direction due to the flow of air.

[0059]

When the vacuum chamber reaches the desired degree of vacuum, all the position holding guides 61 are simultaneously withdrawn and the upper panel is dropped onto the lower panel 1a, thereby bonding the upper and lower panels 1a and 1b to each other. Since the air resistance does not exist in vacuum and thus the upper panel 1b is vertically dropped, the upper panel 1b is dropped to the determined position on the lower panel 1a. Thereafter, the position holding guide 61 is advanced to press the four

corners of the side surfaces of the upper and lower panels 1a and 1b. Then, the pressing plate 27 is further lowered so as to press the upper and lower panels 1a and 1b, thereby bonding the panels 1a and 1b with a desired gap therebetween.

[0060]

In the present embodiment, since the position holding pieces 51 and the guide mechanisms shown in Fig. 2 form a single body, it is possible to reduce the number of components and to simplify the panel assembling apparatus.

[0061]

Although not shown in the figure, the guide mechanisms 56 may be combined as shown in Fig. 2 and the pressing may be performed in a state where the position holding guides 61 are withdrawn.

[0062]

Figs. 8 and 9 are diagrams illustrating sixth and seventh embodiments of the present invention. Here, the pressing plate 27 has a function of holding the upper panel 1b in vacuum.

[0063]

In the figures, the same elements as shown in Fig. 5 are denoted by the same reference numerals and descriptions thereof will be omitted.

[0064]

In Fig. 8, the pressing plate 27 is made of an

insulating member having an electrode plate therein and has an electrostatic adsorptive function of holding the upper panel 1b.

[0065]

In Fig. 9, the pressing plate 27 has an adhering portion 62 for holding the upper panel 1b by means of adhesion and a cylinder 63 for driving the adhering portion 62, which are built in.

[0066]

In the figures, after the pressing plate 27 holds the upper panel 1b by means of the electrostatic adsorption or with the adhering portion 62, the vacuum chamber is decompressed.

[0067]

At this time, since the upper panel 1b is held by means of the electrostatic adsorption or with the adhering portion 62, the upper panel 1b is not dropped from the pressing plate 27 in vacuum and is not moved.

[0068]

When the vacuum chamber reaches the desired degree of vacuum, the holding of the upper panel 1b is released (the electrostatic adsorption is released or the adhering portion 62 is withdrawn into the cylinder 63 in the pressing plate 27) so as to drop the upper panel 1b onto the lower panel 1a, thereby bonding the upper and lower panels 1a and 1b to each

other.

[0069]

Since the air resistance does not exist in vacuum and thus the upper panel 1b is vertically dropped, the upper panel 1b is dropped to the determined position on the lower panel 1a. Then, the pressing plate 27 is further lowered so as to press the upper and lower panels 1a and 1b, thereby bonding the panels 1a and 1b with a desired gap therebetween.

[0070]

As shown in Figs. 8 and 9, the position holding guides 56 may be combined or omitted.

[0071]

In the two embodiments described above, the upper and lower panels 1a and 1b having the same size may be used. In addition, since the panels are not moved in the X and Y directions in the course of bonding the panels with a desired gap therebetween, it is not necessary to perform the positioning step at the time of bonding the panels. Furthermore, since the bonding is performed for a short time by dropping the panel, the productivity is improved.

[0072]

The present invention is not limited to the embodiments described above but may be embodied as follows.

(1) The movement preventing mechanism or the holding mechanism of the lower panel 1a or the upper panel 1b may be

built in the θ stage 4c or the table 9. Alternatively, the movement preventing mechanism or the holding mechanism may be provided to the upper chamber unit 21.

[0073]

(2) The movement preventing mechanism and the holding mechanism may be combined for use.

[0074]

(3) In the present invention, the upper and lower panels 1a and 1b may have the same shape. In addition, when the upper and lower panels 1a and 1b have different shapes, they can be bonded by setting the movement preventing mechanism or the holding mechanism to the shapes.

[0075]

(4) The present invention can be applied to not only bonding liquid crystal display panels but also bonding other panels.

[0076]

[Advantages]

According to the present invention described above, even when the upper and lower panels have different shapes, it is possible to bond the two panels to each other in vacuum. In addition, according to the present invention, it is possible to enhance productivity by bonding the panels to each other in vacuum for a short time.

[Brief Description of the Drawings]

[Fig. 1]

Fig. 1 is a schematic diagram illustrating an entire structure of a panel assembling apparatus according to an embodiment of the present invention.

[Fig. 2]

Fig. 2 is a partial cross-sectional view of a panel bonding unit illustrating a state where two panels are bonded in the panel assembling apparatus shown in Fig. 1.

[Fig. 3]

Fig. 3 is a partial plan view of the panel bonding unit illustrating a state where two panels are bonded in the panel assembling apparatus shown in Fig. 1.

[Fig. 4]

Fig. 4 is a partial cross-sectional view of the panel bonding unit illustrating a state where two panels are bonded according to a second embodiment of the present invention.

[Fig. 5]

Fig. 5 is a partial cross-sectional view of the panel bonding unit illustrating a state where two panels are bonded according to a third embodiment of the present invention.

[Fig. 6]

Fig. 6 is a partial cross-sectional view of the panel

bonding unit illustrating a state where two panels are bonded according to a fourth embodiment of the present invention.

[Fig. 7]

Fig. 7 is a partial cross-sectional view of the panel bonding unit illustrating a state where two panels are bonded according to a fifth embodiment of the present invention.

[Fig. 8]

Fig. 8 is a partial cross-sectional view of the panel bonding unit illustrating a state where two panels are bonded according to a sixth embodiment of the present invention.

[Fig. 9]

Fig. 9 is a partial cross-sectional view of the panel bonding unit illustrating a state where two panels are bonded according to a seventh embodiment of the present invention.

[Reference Numerals]

S1: LIQUID CRYSTAL DROPPING UNIT

S2: PANEL BONDING UNIT

1a: LOWER PANEL

1b: UPPER PANEL

9: TABLE

10: LOWER CHAMBER UNIT

21: UPPER CHAMBER UNIT

27: PRESSING PLATE

51: POSITION HOLDING PIECE

56: GUIDE MECHANISM

57: POSITIONING PIECE

58: PANEL HOLDING GUIDE

59: SHAFT

60: PANEL HOLDING MEMBER

61: POSITION HOLDING GUIDE

62: ADHERING PORTION

63: CYLINDER